Projected ocean warming constrained by the Argo-era ocean observational record

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Abstract

With about 90% of the excess heat from anthropogenic climate change stored in the ocean, an accurate estimate and attribution of global ocean warming is critical in tracking the Earth's energy imbalance and assessing the status of climate change. Historical in situ ocean measurements suffered from large spatial-temporal gaps, bringing uncertainties and potential biases in estimating the historical ocean warming. Since the early 2000s, the international Argo array of autonomous profiling floats has been providing continuous near-global ocean data coverage for the upper 2000 m. Using latest climate model simulations from the Coupled Model Intercomparison Project Phase 6 (CMIP6), here we examine the roles of external forcing and internal climate variability in the global ocean warming over the Argo period (2005–2019). Compared to earlier or longer historical periods, the recently well-sampled Argo period is dominated by increased greenhouse gas forcing but less affected by the anthropogenic aerosol and volcanic eruptions. Corresponding to an El Niño-like tendency over this period, we estimate a small net warming effect of the global ocean from the decadal ENSO variability. We find that the observed ocean warming over the Argo period is a useful constraint on climate model projections of future ocean warming. Based on the emergent constraint methodology, the upper tail of the projected ocean warming from the latest climate models with high climate sensitivities is unrealistically large, as these models tend to overestimate the recent ocean warming. Our findings demonstrate the value of the current ocean observing system for not only understanding the contemporary changes and variability but also for informing the future.

Keywords: ocean warming, ocean heat content, Argo, CMIP6, ENSO, emergent constraint

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